REPORT DOCUMENTATION PAGE

Form Approved OMB NO. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
29-02-2012	Abstract	-

4. TITLE AND SUBTITLE

A Novel Methodology for Exposing Tissue Cultures to Blast Overpressure for Determining Injury Criteria

5a. CONTRACT NUMBER
W911NF-10-1-0526

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
611103

6. AUTHORS

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5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSOR/MONITOR'S ACRONYM(S)
ARO

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
58155-LS-MUR.10

12. DISTRIBUTION AVAILIBILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

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14. ABSTRACT

Introduction: A growing number of clinicians and scientists acknowledge that there exists some level of primary blast exposure that can disrupt or damage neuronal tissue resulting in traumatic brain injury. This injury may be associated with persistent and progressive sequelae. While the groundwork for identifying the brain's tolerance to primary blast has been created using animal and computational models, the mode (volumetric or deviatoric) and threshold of tissue-level deformation associated with brain tissue injury remains unknown. We report here a new

15. SUBJECT TERMS

blast exposure, brain tissue, blast overpressure, shock-tube

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	15. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
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Materials and Methods: Blast waves were generated by a helium-driven shock tube (76 mm diameter tube with a 25 mm driver and a 1220 mm driven section). The blast wave impacts a fluid-filled apparatus that contains living brain tissue, creating a single overpressure pulse that propagates through the suspended tissue. Downstream, the apparatus was designed to mitigate returning shock reflections. An axisymmetric numerical model of the apparatus and tissue was developed in LS-DYNA to assess the response of the tissue that could not be measured experimentally. Experimental and modeled results were compared.

Results and Discussion: The apparatus was able to generate blast overpressure waves at the tissue culture that were characteristic of Friedlander blast waves with minimal amount of reflected overpressure, but with slightly longer rise times (Figure 1A). Peak reflected overpressures generated using the shock tube ranged from 500 to 1500 kPa with durations from 0.5 to 1.0 ms. The numerical model was validated using the experimental results for both the external shock tube overpressure response and the fluid-filled environment at the location of the tissue culture (Figure 1B). Analysis of the numerical model showed minimal deviatoric deformation in the tissue culture.

Conclusions: The test apparatus was developed to simulate the in vivo conditions of tissue within a brain exposed to a single blast wave by sustaining the tissue culture in fluid that has been impacted by a shock tube-generated blast. Since results indicate that the experimental apparatus was effective in isolating the tissue from deviatoric stress, this apparatus and model can be utilized for studying overpressure-based injury criteria. Pressure-based injury criteria will be further enhanced in future studies by extending the range of input overpressures on the living brain tissue, as well as identifying additional measures of histopathologic tissue damage and functional impairment from electrophysiology measurements.

A Novel Methodology for Exposing Tissue Cultures to Blast Overpressure for Determining Injury Criteria

Target Track: Neural Engineering

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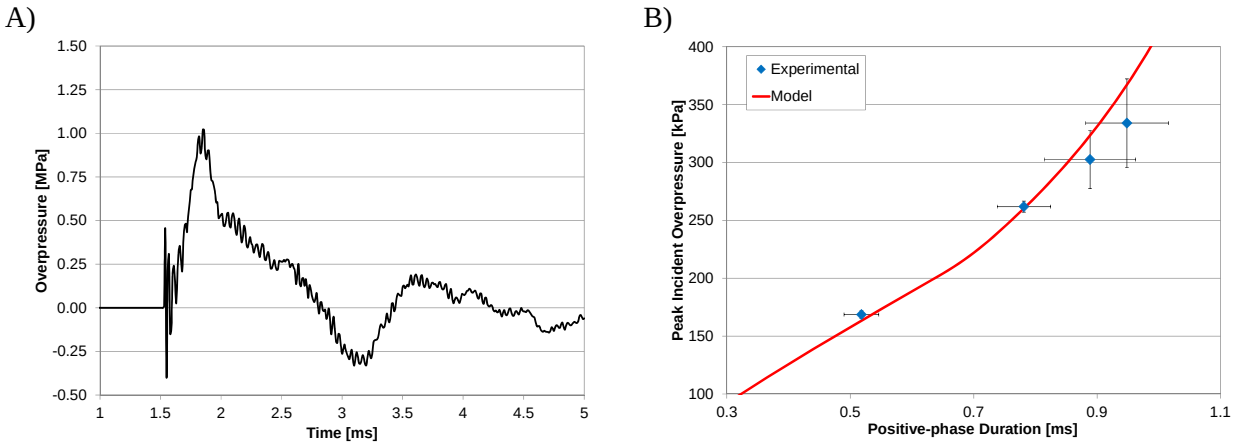

Figure 1: A) A typical overpressure time-history at the tissue produced by the shock tube, and B) the validation of the shock tube model using the external shock tube overpressure response

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